

United States Environmental Protection Agency, Region IX

Air Division

Technical Support Document

for

EPA's Notice of Proposed Rulemaking

for the

Arizona State Implementation Plan

Maricopa County Environmental Services Department

Rule 338

Semiconductor Manufacturing

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Agency Name: Maricopa County Environmental Services Department (Maricopa)

Rule Number and Name: Rule 338 - Semiconductor Manufacturing

District Adoption Date: June 19, 1996

Submittal Date: February 26, 1997

Rule Summary:

Rule 338, "Semiconductor Manufacturing," is a new rule that controls the emissions of volatile organic compounds (VOCs) from all semiconductor manufacturing operations.

Rule 338 requires that semiconductor manufacturers that emit more than 25 tons per year (tpy) of VOC from negative photoresist operations vent these emissions to an emission control system with an overall control efficiency of at least 80%. Facilities that emit more than 50 tpy of VOC from positive photoresist operations must vent these emissions to a control system with at least 80% efficiency; however, the rule exempts emissions from positive photoresist operations that use liquids that contain less than 10% VOC by weight and never exceed a temperature of 104°F.

The rule also contains the following requirements:

- operation and maintenance plan specifying key system operating parameters for the emission control system [304]
- closed containers for storage of VOC-containing materials (incl. discarded materials) [305]
- five-year record retention [502]
- monthly records of VOC-containing material usage [502.2]
- equipment operating records [502.3]

In Section 307.2, Rule 338 exempts quality control operations from the emission control system requirements if the sum of daily emissions from all exempted operations does not exceed 40 pounds.

Rule Evaluation:

Maricopa Rule 338 was evaluated for consistency with the Clean Air Act (CAA), 40 CFR Part 51, and EPA's VOC policy. There is no Control Technique Guideline (CTG) document for this source category. The rule was also evaluated against the control provisions in *Model Volatile Organic Compound Rules for Reasonably Available Control Technology* (June 1992) and *Issues Relating to VOC Regulation Cutpoints, Deficiencies, and Deviations: Clarification to Appendix D of November 24, 1987 Federal Register* (May 25, 1988).

Rule Deficiencies:

Rule 338 contains no significant deficiencies and fulfills the RACT requirements of CAA Section

182(a)(2)(A).

To improve the rule in future amendments of Rule 338, EPA recommends that Maricopa revise the VOC definition to be consistent with EPA's VOC definition. The definition of "non-precursor organic compound" in Section 204 does not include all compounds designated by EPA as having negligible photochemical reactivity (see 40 CFR 51.100(s)). This inconsistency is not considered a rule deficiency because EPA does allow districts to control EPA exempt compounds provided that the emission reductions associated with the compounds are not credited towards the SIP.

EPA Recommendation:

EPA has determined that Rule 338, "Semiconductor Manufacturing," is consistent with the CAA and EPA policy and will reduce VOC emissions from semiconductor manufacturing operations. Approval of the rule strengthens the Arizona State Implementation Plan by adding a RACT rule for this source category. Therefore, the EPA recommends that the submitted rule be approved under Section 110(k)(3) of the CAA.

Attachments:

1. Submitted Maricopa Rule 338, "Semiconductor Manufacturing" (Adopted June 19, 1996)
2. *Issues Relating to VOC Regulation Cutpoints, Deficiencies, and Deviations: Clarification to Appendix D of November 24, 1987 Federal Register (The "Blue Book"), May 25, 1988*
(Cover only)

REGULATION III - CONTROL OF AIR CONTAMINANTS

RULE 338 SEMICONDUCTOR MANUFACTURING

INDEX

SECTION 100 - GENERAL

- 101 PURPOSE

SECTION 200 - DEFINITIONS

- 201 APPROVED EMISSION CONTROL SYSTEM
- 202 MASKING
- 203 NEGATIVE PHOTORESIST OPERATION
- 204 NON-PRECURSOR ORGANIC COMPOUND
- 205 PHOTORESIST MASKANT, MASKANT, OR PHOTORESIST
- 206 POSITIVE PHOTORESIST OPERATION
- 207 SEMICONDUCTOR MANUFACTURE
- 208 SOLVENT
- 209 STRIPPING
- 210 VOLATILE ORGANIC COMPOUND (VOC)

SECTION 300 - STANDARDS

- 301 NEGATIVE PHOTORESIST OPERATIONS
- 302 POSITIVE PHOTORESIST OPERATIONS
- 303 OPERATION AND MAINTENANCE PLAN
- 304 MAINTENANCE
- 305 STORAGE AND DISPOSAL OF VOC
- 306 CLEANING AND CLEANUP
- 307 EXEMPTIONS

SECTION 400 - ADMINISTRATIVE

- 401 COMPLIANCE SCHEDULE

402 COMPLIANCE WITH RULE331

SECTION 500 - MONITORING AND RECORDS

501 PROVIDING AND MAINTAINING MONITORING DEVICES

502 RECORDKEEPING AND REPORTING

503 COMPLIANCE DETERMINATION - TEST METHODS

**MARICOPA COUNTY
AIR POLLUTION CONTROL REGULATIONS**

REGULATION III - CONTROL OF AIR CONTAMINANTS

**RULE 338
SEMICONDUCTOR MANUFACTURING**

SECTION 100 - GENERAL

- 101 PURPOSE:** To limit the emission of volatile organic compounds from semiconductor manufacturing.

SECTION 200 - DEFINITIONS: For the purpose of this rule, the following definitions shall apply:

- 201 APPROVED EMISSION CONTROL SYSTEM** - A system for reducing emissions of organic compounds, consisting of both emissions collection and processing devices which are approved in writing by the Control Officer and are designed and operated in accordance with good engineering practice.
- 202 MASKING** - Applying a photoresist maskant material or overlaying a stencil to apply, impress, transfer, or otherwise effect a pattern on or into another substance.
- 203 NEGATIVE PHOTORESIST OPERATION** - A process for the application of negative photoresist masking solution/material on a wafer or other substrate which hardens when exposed to light or other process-radiation. This includes preparation, soft bake, hard bake, developing, stripping and edge bead removal, as well as any intermediate operations.

- 204 NON-PRECURSOR ORGANIC COMPOUND** - Any of the following organic compounds which have been designated by the EPA as having negligible photochemical reactivity: methane; ethane; methylene chloride (dichloromethane); 1,1,1-trichloroethane; trichlorofluoromethane (CFC-11); dichlorodifluoromethane (CFC-12); chlorodifluoromethane (CFC-22); 1,1,2-trichlorotrifluoroethane (CFC-113); 1,2-dichlorotetrafluoroethane (CFC-114); chloropentafluoroethane (CFC-115); trifluoromethane (FC-23); 2,2-dichloro-1,1,1-trifluoroethane (HCFC-123); 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124); 1,1-dichloro-1-fluoroethane (HCFC-141b); 1-chloro-1,1-difluoroethane (HCFC-142b); pentafluoroethane (HFC-125); 1,1,2,2-tetrafluoroethane (HFC-134); 1,1,1,2-tetrafluoroethane (HFC-134a); 1,1,1-trifluoroethane (HFC-143a); 1,1-difluoroethane (HFC-152a); all completely fluorinated, completely saturated: alkanes, ethers and tertiary amines.
- 205 PHOTORESIST MASKANT, MASKANT, OR PHOTORESIST** - A coating applied directly to a component to protect surface areas when chemical milling, etching, or other chemical surface operations are performed on the component.
- 206 POSITIVE PHOTORESIST OPERATION** - A process for the application of positive photoresist masking solution/material on a wafer or other substrate which softens when exposed to light or other process-radiation. This includes preparation, soft bake, hard bake, developing, stripping and edge bead removal, as well as any operations intermediate to such processes. Positive photoresist equipment cleaning operations are not included.
- 207 SEMICONDUCTOR MANUFACTURE** - Any process or operation performed to produce semiconductor devices or related solid state devices, including but not limited to diodes, zeners, stacks, rectifiers, integrated microcircuits, transistors, solar cells, light-sensing devices, and light-emitting devices.
- 208 SOLVENT** - Any material which contains VOC and/or any non-precursor organic compound and which can dissolve or hold in suspension another substance. This includes but is not limited to developers and stripping agents.
- 209 STRIPPING** - The removal of spent photoresist maskant from the product after etching, or the removal of oxide or other stencil agent from the product after diffusion.
- 210 VOLATILE ORGANIC COMPOUND (VOC)** - Any organic compound except the non-precursor organic compounds.

SECTION 300 - STANDARDS

- 301 NEGATIVE PHOTORESIST OPERATIONS:** No person shall allow negative photoresist operations at a semiconductor manufacturing facility annually emitting more than 25 tons (22.7 Mg) of VOC from all negative photoresist operations combined unless such VOC-containing vapors are vented to an Approved Emission Control System which reduces their total weight by at least 80 percent (capture with processing). The emission reduction will be determined for the sum of all VOC emissions from negative photoresist operations before any of these emissions enter an emissions control device.
- 302 POSITIVE PHOTORESIST OPERATIONS:** No person shall allow positive photoresist operations at a semiconductor manufacturing facility annually emitting more than 50 tons (45.4 Mg) of VOC from all non-exempt positive photoresist operations combined, unless VOC-containing vapors are vented to an Approved Emission Control System which reduces the weight of VOC emissions from all such non-exempt operations combined by at least 80 percent (capture with processing). The emission reduction will be determined for the sum of all non-exempt VOC emissions from positive photoresist operations before any of these emissions enter an emissions control device. Non-exempt refers to VOC emissions that are not specifically exempted by Section 307 of this rule.
- 303 OPERATION AND MAINTENANCE PLAN:** The owners or operators of an Emission Control System required by this rule shall provide the Control Officer with an Operation and Maintenance (O&M) Plan. This plan shall specify key system operating parameters, such as temperatures, pressures and/or flow rates, necessary to determine compliance with this rule and describe in detail procedures to maintain the Emission Control System. The Control Officer's written approval of this plan shall be required for compliance with this rule to be achieved.
- 304 MAINTENANCE:** All active process equipment in which VOC-containing materials are used shall be operated and maintained in proper working order.
- 305 STORAGE AND DISPOSAL OF VOC:** All storage of VOC-containing materials subject to evaporation, including the storage of waste solvent and waste solvent residues, shall at all times be in closed containers which are legibly labelled with their contents. Records of disposal/recovery of VOC-containing materials shall be kept in accordance with hazardous waste disposal statutes.

306 CLEANING AND CLEANUP: A cleaning or cleanup operation using solvents over 10 percent VOC by weight must conform at a minimum to the applicable provisions of Rule 331 if such operation is not served by an external control device which reduces the overall weight of VOC emissions from such an operation by at least 80 percent (capture with processing). This applies to the cleaning of parts and products as well as to the cleaning of those materials and assemblies that are intermediate to them. This also applies to the cleaning of production equipment, to general cleanup, and to stripping operations using solvents over 10 percent VOC by weight.

307 EXEMPTIONS:

307.1 Liquids in positive photoresist processes which contain less than 10 percent VOC by weight and never exceed a temperature of 104°F (40°C) are allowed the following exemptions. VOC emissions from such liquids:

- a. Are not included in the calculations determining if positive photoresist operations are subject to the control device provisions of Section 302;
- b. Are exempt from any requirement that they be controlled by an Approved Emission Control System;
- c. Are not included in determining the efficiency of a required Approved Emission Control System unless (optionally) captured by such a System.

307.2 Quality Control Operations: Except for this rule's Sections 305, and 306, and subsections 502.1 and 502.2, this rule shall not apply to those operations within a semiconductor manufacturing facility which are used exclusively for chemical or physical analysis, or determination of product quality and commercial acceptance. Such operations may be exempted until the sum of daily emissions from all exempted operations reaches but does not exceed 40 pounds (18.1 kg). This exemption shall not apply to a particular operation if:

- a. The operation is an integral part of the production process; or
- b. The exemption is denied in writing by the Control Officer.

SECTION 400 - ADMINISTRATIVE

- 401 COMPLIANCE SCHEDULE:** By February 14, 1993, any person subject to Section 301 or 302 who does not comply with all provisions of Section 301 or 302 shall submit for the Control Officer's approval an emission control plan describing the method to be used to achieve full compliance. Facilities emitting over 100 tons (90.7 Mg) per year of VOC emissions must achieve compliance by November 15, 1993. Other affected facilities emitting less than 100 tons (90.7 Mg) per year of VOC must achieve compliance by May 15, 1994. The plan shall specify dates for completing increments of progress, such as the contractual arrival date of new control equipment. The Control Officer may require a person submitting such emission control plan to submit subsequent reports on progress in achieving compliance.
- 402 COMPLIANCE WITH RULE 331:** Any operation or facility which is exempt from all or a portion of this rule shall comply with the applicable provisions of Rule 331 as well as any other applicable rules of these Rules and Regulations.

SECTION 500 - MONITORING AND RECORDS

- 501 PROVIDING AND MAINTAINING MONITORING DEVICES:** Any person operating an Approved Emission Control System pursuant to this rule shall provide, properly install and maintain in calibration, in good working order and in operation, devices described in an approved O&M Plan for indicating temperatures, pressures, rates of flow, or other operating conditions necessary to determine if air pollution control equipment is functioning properly and is properly maintained.
- 502 RECORDKEEPING AND REPORTING:** Any person subject to this rule shall comply with the following requirements. Records shall be retained for five years and shall be made available to the Control Officer upon request.
- 502.1 Current List:** Maintain a current list of coatings, adhesives, maskants, solvents, and any other VOC-containing materials. State the VOC content of each in pounds per gallon or grams per liter.
- 502.2 Usage Records:** Maintain monthly records showing the type and amount of all VOC-containing material in photoresist operations. This includes, but is not limited to strippers, maskants, solvent materials and cleanup materials
- 502.3 Operation and Maintenance:** Maintain a continuous record of the times an Emission Control Device is used to comply with this rule. Maintain daily records of the O&M Plan's key system operating-parameters. Maintain records of all maintenance performed according to the O&M Plan.

503 COMPLIANCE DETERMINATION - TEST METHODS: When more than one test method is permitted for a determination, an exceedance of the limits established in this rule determined by any of the applicable test methods constitutes a violation of this rule.

503.1 Sample Analysis: VOC content of materials shall be determined using the applicable EPA Reference Method 24 or 24A (40 CFR, Part 60, Appendix A).

503.2 Emission Testing: Control efficiency of an emissions control device shall be determined according to EPA Reference Method 25 or an applicable submethod of Method 25 (Title 40, CFR Part 60, Appendix A).

503.3 Capture Efficiency: Capture efficiency shall be determined by mass balance in combination with ventilation/draft rate determinations "Using a Temporary Total Enclosure For Capture Efficiency Testing," EPA-450/4-91-020.

503.4 Ventilation/Draft Rates: Ventilation/draft rates shall be determined by EPA Methods 2, 2A, 2C, or 2D.

***ISSUES RELATING TO VOC REGULATION
CUTPOINTS, DEFICIENCIES, AND DEVIATIONS***

***Clarification to Appendix D
of November 24, 1987 FEDERAL REGISTER***

May 25, 1988

***Ozone/Carbon Monoxide Program Branch
Air Quality Management Division
Office of Air Quality Planning and Standards***